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(71) Applicant: STUHR ENTERPRISES, INC. [US/US]; 4785 Spring Circle, Minnetonka, MN 55345-3416 (US).

(72) Inventor: STUHR, Roger, R.; 4785 Spring Circle, Minnetonka, MN 55345-3416 (US).

(74) Agents: THUENTE, John, F. et al.; Patterson & Keough, P.A., 1200 Rand Tower, 527 Marquette Avenue South, Minneapolis, MN 55402 (US).

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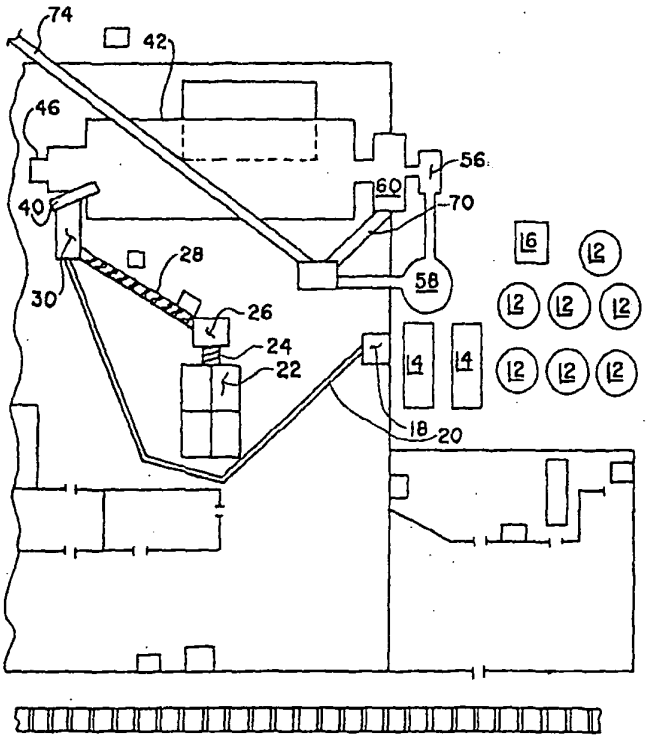
(54) Title: PROCESS FOR MAKING AN ANIMAL FEED SUPPLEMENT

(57) Abstract

A process for an animal feed supplement includes the steps of mixing liquid substrate (12, 14) and a dry substrate (22) at a liquid:dry ratio of about 1.0:1.0 to about 3.0:1.0 to form a slurry in mixing chamber (30); drying the slurry in a continuous flow dryer (42) having mixing capabilities and a source of moving hot air to about 1 wt.% – 10 wt.% moisture. The animal feed supplement which results from the process is characterized by generating less than 20 pm of ammonia in the gases above a 100 gram sample immediately after heating for 1 minute in a 1000 watt microwave. The liquid substrate is selected from materials such as glutamic acid fermentation bamboos and fermented molasses solubles (FM) and mixtures thereof. The dry substrate is selected from: wheat middlings and similar materials. The animal feed supplement is palatable to cattle under hot conditions (temperatures around 100 °F). The animal feed supplement reduces the likelihood of milk fever feed at a rate of from about 1.5 to about 2.5 pounds/day.



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PROCESS FOR MAKING AN ANIMAL FEED SUPPLEMENT

CROSS-REFERENCE TO RELATED APPLICATION

The present application claims priority under 35 U.S.C. § 119(e) to U.S. Provisional Application Serial Number 60/045,696, filed May 6, 1997.

BACKGROUND

The present invention relates to a process for making an animal feed supplement and, in particular, the present invention relates to a process for making a feed supplement with increased stability and palatability. The resulting product has nutritional disease preventive properties.

For many years calcium deficiencies ("hypocalcemia") have been a problem in lactating cows. The problem is typically known as "milk fever" and may, in chronic cases, reduce a cow's milk output by roughly 14%. In very extreme cases the cow may die. The problem has been estimated to affect about 8% of dairy cows and have an annual economic cost to the U.S. in excess of $140 million.

During the prepartum period of the cow's life, the cow's electrolyte balance becomes unstable and may result in an alkaline condition. This causes difficulty in proper absorption of calcium in the diet and causes a disease know as "Milk Fever" upon partum or shortly thereafter.

Milk Fever is also thought to be associated with an imbalance in nutrition which reduces the efficiency of the microbes in a cow's rumen. It has been suggested that the nitrogen, supplied in the cow's diet as protein may often be a limiting factor in rumen efficiency. To rectify that situation, cows are sometimes provided a diet with added protein or amino acids. Additionally, the cation-anion balance in a cow's diets is significant, particularly with respect to "Milk Fever" since excessive anion and high pH may result in reduced feed intake. An accepted monitor of this balance is the pH of urine, with pH 8 being a generally accepted upper pH limit and pH 7 being a more desirable goal. Addition of ammonium

chloride, ammonium sulfate, calcium chloride and calcium sulfate to the cow's diet would help adjust the cation-anion balance, however, such products are unpalatable to cows. (Some authorities, however, recommend against the ammonium salts.)

The Julien patent, U.S. 5,709,894, incorporated herein by reference, discloses a feed additive for ruminants. The Julien feed additive comprised dried glutamic acid fermentation solubles, dried corn fermentation solubles or, preferably, a mixture of the two, wherein the dried solubles were dried to less than 30% by weight moisture at a temperature not less than 80°F and not more than 900°F, for enhancing ruminal microbial fermentation and increasing the amount of microbial protein delivered to the digestive organs of a rumen relative to undried solubles. The Julien additive may include a carrier, such as wheat middlings. The drying process is taught by Julien as involving exposure to forced air at a temperature of not less than 80°F and not more than 900°F, preferably not less than 190°F and not more than 280°F for a period of not less than 3 minutes. The resulting material is cooled to about 90°F and then about 1/3 of the cooled material is recycled, to be reblended and redried to about 15% by weight final moisture. During the drying, enzymes and amino acids also may be added.

Several observers have shared the present inventors view that the commercial product, BioChlor from BioVance of Omaha, Nebraska, which is believed to correspond to the Julien '894 patent feed additive has an undesirable tendency to release ammonia, particularly when exposed to temperatures of about 135°F and therefore appears to be somewhat unpalatable to cattle. Also, the BioChlor feed additive is hygroscopic and tends to conglomerate or "bridge" in bags rather than flowing smoothly, a property required for efficient handling in most commonly employed agricultural mixing and feeding equipment.

It would highly valuable to improve upon the process and product of Julien to provide improved stability, palatability and ease of handling. The subsequently described invention achieves that goal by providing a

process for applying feed grade liquid materials, such as a liquid glutamic fermentation biomass and fermented molasses solubles (FMS), to a dry carrier, such as wheat middlings, to form a supplement characterized by a high percentage of dry matter and superior stability of the active ingredients from volatilizing to noxious and unpalatable gases under high heat.

SUMMARY OF THE INVENTION

The present invention includes a process for preparing an animal feed supplement, the process includes the steps of (1) providing a feed grade liquid substrate including biomass, which biomass includes ammonium chloride and a protein source; (2) providing a feed grade dry substrate; (3) mixing the feed grade liquid substrate and the feed grade dry substrate at a predetermined liquid:dry ratio of from about 1.0:1.0 to about 3.0:1.0 to form a slurry; (4) transferring the slurry, at a predetermined rate and under continuous mixing conditions, into a continuous flow dryer having mixing capabilities and a source of moving hot air; (5) drying the slurry under predetermined temperature and duration conditions to about 1 wt % - 10 wt % moisture, preferably from about 6.0 wt % to about 8.0 wt %, and most preferably about 7 wt % moisture, without allowing the cold blend to reach a temperature detrimental to the ammonium chloride component or the protein component, thereby forming a product having about 90-99 wt % solids, preferably about 92-94 wt % solids, and most preferably 93 wt % solids; (6) slowly cooling the resultant material in ambient air by contacting a heat sink to form the animal feed supplement. The animal feed supplement which results from the process is characterized by generating less than about 20 ppm of ammonia in the gases above a 100 gram sample immediately after heating for 1 minute in a 1000 watt microwave. Preferably, the liquid substrate with biomass is selected from the group consisting of glutamic acid fermentation biomass and fermented molasses solubles (FMS). Preferably, the dry feed grade substrate is selected from the group consisting of wheat middlings, ground

soy hulls, ground rice hulls, and similar ground feed grade by products which will absorb the excess liquid of the biomass product.

The present invention, in another embodiment, is also a product produced by the process of this invention. The product is palatable to livestock, such as cattle. The palatability is maintained under hot conditions, for example weather at or above 100°F. Prior art products, such as the product sold under the trademark BioChlor, by BioVance, tend to become unpalatable to cattle under such conditions and in hot, humid conditions will absorb moist from the air which will result in clumping of the product resulting in bridging in a mixing and feeding apparatus. This is due to the hygroscopic nature of the prior art product.

The present invention, in yet another embodiment, is a process for treating dairy cows to reduce the likelihood of milk fever. The treatment process includes the step of: (1) feeding the product of the earlier described process to cows during the "dry period" preceding lactation, wherein the product of the process is fed at a rate of from about 1.5 to about 2.5 pounds day per head, preferably 2.0-2.5 pounds per day per head.

BRIEF FIGURE DESCRIPTIONS

FIG. 1 is a schematic view of the process of the present invention as arranged at a plant site for practicing the present invention;

FIG. 2 is a schematic diagram of the mixer from a top view used in the process of Figure 1;

FIG. 3 is a schematic longitudinal cross-sectional diagram of the dryer used in the process of Figure 1; and

FIG. 4 is a schematic cross-sectional diagram of the grinder used in the process of Figure 1.

DETAILED DESCRIPTION

Comprehension of the present invention can be gained through reference to the drawings in conjunction with a thorough review of the following explanation and examples. By "biomass" herein is meant

materials of biological origin such as the byproduct of the production of monosodium glutamate provided as a condensed, extracted glutamic acid fermentation product ((American Feed Control Officials) AFCO T36.1) which is a concentrated mixture of the liquor remaining from the extraction of glutamic acid, combined with the cells of Corynebacterium lilium or Corynebacterium glutamicium used to produce the glutamic acid. Other alternative biomass sources are condensed fermented corn extractives (AFCO) 48.24), or other condensed fermentation solubles (AFCO 36.10) such as cattle whey fermentation solubles condensed (AFCO IFN 5-06-300), cereals grain fermentation solubles condensed (AFCO IFN 4-07-153) and sugarcane molasses fermentation solubles condensed (AFCO IFN 5-25-399). By "a temperature detrimental" herein is meant a temperature which tends to degrade or volatilize the beneficial nutrient components of the mix such as ammonium chloride, protein, peptides, or any other nutrient susceptible to heat degradation. By "feed grade" herein is meant materials which may be ingested by animals without harming the animal, examples being found in the Official Publication of the Association of American Feed Control Officials. Ingestible materials may or may not be a nutrient source for the animals. Specific examples of ingestible materials include but are not limited to wheat middlings, when the animal is a cow.

DRYING PROCESS

In a first embodiment, the present invention, as depicted in Figure 1, is a process for preparing an animal feed supplement. The process, shown as a plant site 10 for carrying out the invention, includes the steps of (1) providing a feed grade liquid substrate which includes ammonium chloride and a protein source; (2) providing a feed grade dry substrate; (3) mixing the feed grade liquid substrate and the feed grade dry substrate at a predetermined liquid:dry ratio of from about 1.0:1.0 to about 3.0:1.0 to form a slurry; (4) transferring the slurry, at a predetermined rate and under continuous mixing conditions, into a continuous flow dryer having

mixing capabilities and a source of moving hot air; (5) drying the slurry under predetermined temperature and duration conditions to about 1 wt % - 10 wt % moisture without allowing the cold blend to reach a temperature detrimental to the ammonium chloride component or the protein component, thereby forming a product having about 90-99 wt % solids; (6) slowly cooling the resultant material in ambient air by contacting a heat sink to form the animal feed supplement.

At the plant site 10, liquid substrates are stored in holding tanks 12 and 14 and made available for transfer by pumps in a pumphouse 16. A liquid substrate, having a biomass and ammonium chloride, is provided. Preferably, the liquid substrate is a mixture of liquid substrates is prepared and mixed in a desired proportion, for example, approximately a 50/50, more preferably a 60/40, as a weight ratio, of monosodium glutamate fermentation byproduct liquor (MSGL) to condensed fermentation solubles (CFS) (a byproduct from lysine production) as they are loaded on a tank truck at point of pickup. This liquid blend is then mixed again in the holding tank 12 or 14 by surging air into the tank 12 or 14 to assure and maintain a good mix prior to processing. The liquid substrate mixture is controlled by variable speed pump 18 which forces and controls its injection into line 20.

The liquid substrates for use in the present invention include biomass may be the byproduct of the production of monosodium glutamate provided as a condensed, extracted glutamic acid fermentation product ((American Feed Control Officials) AFCO T36.1) which is a concentrated mixture of the liquor remaining from the extraction of glutamic acid, combined with the cells of Corynebacterium lilium or Corynebacterium glutamicium used to produce the glutamic acid. This product has been sold primarily as a liquid as an ingredient in liquid feeds over the past 5 years. Other appropriate liquid materials may be condensed fermented corn extractives (AFCO) 48.24), or other condensed fermentation solubles (AFCO 36.10) such as cattle whey fermentation solubles condensed (AFCO IFN 5-06-300), cereals grain fermentation

solubles condensed (AFCO IFN 4-07-153) and sugarcane molasses fermentation solubles condensed (AFCO IFN 5-25-399).

The dry substrate is stored in overhead storage bins 22, from which the dry substrate drops to auger 24. The dry substrate may optionally be ground in grinder 26. The dry product is carried in auger 28 to the mixing chamber 30.

The dry substrate may be wheat middlings or another dry substrate selected from the group consisting of wheat middlings, ground soy hulls, ground rice hulls, and similar ground feed grade byproducts which will absorb the excess liquid of the liquid biomass product.

The mixing chamber 30, as depicted in greater detail in Figure 2, receives dry substrate from auger 28 and liquid substrate mix from line 20. The mixing chamber is a twin drum, twin paddle mixer. The mixing chamber may optionally be heated by a steam heated pipe having a temperature of 130 °F or in the alternative not heated.

The dry substrate is dispersed into the mixing chamber 30 by the loading box 32. The dry and liquid substrates are mixed within the mixing chamber 30 by two variable speed sets of paddles 34, 36. The paddles 34, 36 are carefully designed to counter rotate and with the intersecting paddle agitators, this mixing chamber 30 creates a fluidized bed zone mixing action which virtually lifts all liquid and dry ingredients to a weightless-like condition.

In addition, these critically positioned and overlapping paddles 34, 36 create an environment in which each particle is transferred, circulated and coated throughout the mixing chamber 30. The twin drum, twin paddle configuration of the mixing chamber 30 permits all materials to move freely within the mixing chamber 30. The combination of liquid substrates and dry substrate experiencing weightless-like conditions and tremendous product movement of all particles creates a dynamic interaction in which the mixing chamber 30 moves, disperses and mixes liquid substrates and dry substrates faster than gravity is able to segregate those materials. This results in a complete homogeneous, rapid and

precise mixture where the most essential ingredients behave as if they are protected by the liquid substrate and the dry substrate.

While not wishing to be bound by theory, and by way of explanation only, it is the inventors' understanding of the present invention that the blending of the dry substrate and liquid biomass has a unique result in that it allows the liquid biomass to be mixed with the dry carrier in a manner that allows the liquid to be, in effect, encapsulated by the dry carrier. This encapsulation protects the essential active ingredients in the liquid substrate from the high temperatures of the ensuing drying process. The liquid enters the mixing chamber 30 at a controlled rate from a variable speed pump 18 thus allowing a predetermined ratio of liquid substrate to dry substrate which is critical to the encapsulation process.

The ratio of the liquid substrate to dry substrate, on a volume to volume basis, is a ratio from 1.0 - 3.0 : 1.0, preferably 2.0-2.5 : 1, and most preferably about 2.25 : 1. When the liquid substrate and the dry substrate are blended in the mixing chamber 30, it is believed that the unique physical mechanical mixing of liquid substrate and dry substrate cause the liquid substrate to be put into a protective physical state, thereby allowing the ammonium chloride subcomponent to be coated by the liquid substrate, which desirably includes biomass including especially, glucans. The thus protected ammonium chloride is then being further protected by the dry substrate. The resulting mix is blended for a precise amount of time which is determined, at least in part, by the relative viscosity of the mixed product. This mix, perhaps better termed a slurry, is then transferred to an auger 40 as shown in Figure 1 and Figure 3. In the auger 40, still further mixing of the slurry is accomplished.

Optionally, the slurry may then be introduced to a second blender or mixer (not shown) where the protective process is further implemented by yet more mixing. The second blender or mixer may be generally identical as the first mixing chamber 30 except that it is kept at lower temperatures than the first mixing chamber 30.

The auger 40, which serves as a slurry feeder, is designed to deliver

the slurry at a precise rate to the dryer 42 thus allowing a controlled rate of heat absorption by the slurry before the active ingredients are damaged by high heat.

The slurry is augered into the dryer 42 by auger 40 such that the slurry is discharged at a point about 6 inches past the mouth 44 of the rotary drum drier 42. At this point, the slurry is first introduced and exposed to the approximately 500 °F heat of the hot air produced by a burner 46 of furnace 47 adjacent the mouth 44 of the drier 42. The temperature of the inlet air of the drier 42, is about 700 °F, but may be adjusted upward or downward to control the desired finish product moisture level.

The slurry is tumbled within the throat 48 of the drier 42 as it turns and is moved forward in the dryer 42 by the turning or rotating of the drum 50 and the blades 52 within the dryer 42 advancing the slurry through the dryer 42 where cooler temperatures prevail. The exhaust air temperature from the dryer 42 is about 250°F. The product temperature at exit 54 is about from about 180°F to about 225°F. The speed of the movement of the drying slurry material as it advances through the drier 42 is determined by the speed of the suction fan 56 which controls the amount and velocity of the air going up the cyclone 58 and the amount and velocity of the air moving through the drum dryer 42.

The speed of the slurry moving through the dryer 42 is critical to the process as the slurry needs to loose water at a predetermined rate to allow it to stay cool enough to protect the essential nutrients and active ingredients from damage by high temperatures. The essential nutrients, including ammonium chloride, are also protected by the slurry mix from the heat by the physical blend of the dry substrate and the liquid substrates. The dryer 42 is designed and operated to carefully move the slurry along the length of the drum 50 at a rate to allow the slurry to evaporate without raising the temperature of the active ingredient excessively and damaging the active ingredients.

The nearly dried slurry moves to the rear of the dryer 42 where it

then enters the dropout box 60 and is then augered, through auger 70 to the grinder 72 where it is reground to equalize the particle size.

Optionally, the ground particles may be moved back to the optional second mixer, optionally for remix with a slurry, and then the combination moved back into the dryer 42 or yet another dryer, for the second pass at drying. The purpose of the optional second pass through the dryer is to allow the product and the ingredient ammonium chloride to remain stable and be dried at a rate to keep the ammonium chloride stable and allow the protective matrix of the glutamic acid fermentation biomass to stay physically surrounding the ammonium chloride to lend added protection from the heat and bind the matrix to the ammonium chloride by a chemical/physical bond which we describe as chemical physical maturation.

If the optional second pass through the drier 42 is made, the product is then dried on the second run to a 90-99% dry matter. This process allows this high degree of drying to allow the water to dissipate without damaging the essential ingredients and allowing the chemical physical maturation to take place.

After drying, whether the optional second pass is employed or not, the dried product is transferred by auger or more preferably by vacuum air conduit 74 to a cooling area (not shown) where it is deposited and allowed to cool by spreading the warm product on a heat sink which cools and "finishes" the process by gently allowing the product to cool in contact with ambient air. The preferred cooling system is designed to allow the dried material to cool at a slow rate by natural ambient temperatures. This is believed to add to the stability of the active ingredients. After cooled, the product and process is complete. Preferably, the product may be bagged for storage or immediate shipment as a bulk product.

PROPERTIES OF AND USE OF THE DRIED PRODUCT

When dried in the process described in the process description, the finished product can be used as an excellent source of dietary protein and

peptides which enhance the growth of the rumen bacteria population in the cow's rumen. This enables the cow to have an excellent supplemental source of protein.

While not wishing to be bound by theory, it is the thought that the positive benefits of the invention are brought about by the product of the process described above which has a good supply of anions so that when fed at the recommended level, the cows' electrolyte balance will be slightly acidogenic thus causing the adequate absorption of calcium. The product is palatable to cattle and readily accepted by cows, even under hot weather conditions.

EXAMPLE: FEEDING STUDY

A study, attached as Appendix A, of the product of this invention, Anion Booster™, has been performed by Swanson, Guy, and Sanchez at the University of Idaho. The authors' summary of their study emphasizes the difference of the product in increased intake by cattle.

> ANION BOOSTER was proven in this trial to increase blood calcium levels and decrease urine pH and HCO3. Dry matter intake was not significantly affected, but the cows ate numerically more of the ANION BOOSTER than the other treatments. The results of this trial concur with the results of previous anionic salt studies in their effects on acid-base status. However, in this study, the ANION BOOSTER as a source of anions did not decrease dry matter intake as is seen with many other studies. This product would appear to be more palatable to the cow but still causes the changes desired in acid-base status, potentially making it a viable product on the market. (Swanson, Guy, and Sanchez)

The animal feed supplement which results from the process is characterized by generating less than 20 ppm of ammonia and more typically less than 10 ppm of ammonia. In the gases above a 100 gram sample immediately after heating for 60 seconds in a 1000 watt microwave. The gases were tested using a Kitagawa gas detector, having a detection range of 5-269 ppm. Comparable tests on the BioChlor product of BioVance indicated more than 260 ppm.

The product of the process of the present invention also is a nonhygroscopic product which provides excellent handling properties. Specifically, the product of this invention does not cake in bags, but rather flows freely. The comparison product, BioChlor, tends to cake and or "bridge" and thus is difficult to handle in normal feed handing equipment.

Preferably, the liquid substrate is a biomass containing substrate with biomass selected from the group consisting of glutamic acid fermentation biomass and condensed fermented solubles (CFS), the byproduct of the production of monosodium glutamate provided as a condensed, extracted glutamic acid fermentation product ((American Feed Control Officials) AFCO T36.1) which is a concentrated mixture of the liquor remaining from the extraction of glutamic acid, combined with the cells of Corynebacterium lilium or Corynebacterium glutamicium used to produce the glutamic acid. Other alternative biomass sources are condensed fermented corn extractives (AFCO) 48.24), or other condensed fermentation solubles (AFCO 36.10) such as cattle whey fermentation solubles condensed (AFCO IFN 5-06-300), cereals grain fermentation solubles condensed (AFCO IFN 4-07-153) and sugarcane molasses fermentation solubles condensed (AFCO IFN 5-25-399). These liquids may be used alone or in combination. Preferably, the dry substrate is selected from the group consisting of wheat middlings, or another dry substrate selected from the group consisting of: wheat middlings, ground soy hulls, ground rice hulls, and similar ground feed grade by products which will absorb the excess liquid of the biomass product. Mixtures of appropriate

dry substrates may also be used.

The present invention, in another embodiment, is also a product produced by the process of this invention. The product is palatable to livestock, such as cattle. The palatability is maintained under hot conditions, for example weather at or above 100°F. Prior art products, such as the product sold under the trademark BioChlor, by BioVance, tend to become unpalatable to cattle under such conditions.

The present invention, in yet another embodiment, is a process for treating dairy cows to reduce the likelihood of milk fever. Treatment process includes the step of: (1) feeding the product of the earlier described process to cows during the "dry period" preceding lactation, wherein the product of the process is fed at a rate of from about 1.5 to about 2.5 pounds day, more preferably about 1.8 - 2.2 pounds per day per head.

Because numerous modifications may be made of this invention without departing from the spirit thereof, the scope of the invention is not to be limited to the single embodiment illustrated and described. Rather, the scope of the invention is to be determined by appended claims and their equivalents.

WHAT IS CLAIMED IS:

1. A process for preparing an animal feed supplement, the process comprising the steps of:

providing a feed grade liquid biomass, the liquid biomass including an ammonium chloride and a protein component;

providing a feed grade dry substrate;

mixing the feed grade liquid biomass and the feed grade dry substrate at a predetermined liquid:dry ratio of from about 1.0:1.0 to about 3.0:1.0 to form a slurry;

transferring the slurry, at a predetermined rate and under continuous mixing conditions, into a continuous flow dryer having mixing capabilities and a source of moving hot air;

drying the slurry under predetermined temperature and duration conditions to about 1 wt % to 10 wt % moisture without allowing the cold blend to reach a temperature detrimental to the ammonium chloride component or the protein component, thereby forming a warm material having about 90-99 wt % solids;

slowly cooling the warm material in ambient air and by contacting a heat sink, thereby completing the process of preparing the animal feed supplement; and

wherein the animal feed supplement is characterized by generating less than 20 ppm of ammonia in the gases above a 100 gram sample immediately after heating for 1 minute in a 1000 watt microwave.

2. The process of claim 1 and wherein the feed grade liquid biomass is selected from the group consisting of:

glutamic acid fermentation biomass, condensed fermented solubles (CFS), cattle whey fermentation solubles condensed, cereals grain fermentation solubles condensed, sugarcane molasses fermentation solubles condensed, and mixtures thereof.

3. The process of claim 1 and wherein the dry substrate is selected from

the group consisting of:

wheat middlings, ground soy hulls, ground rice hulls, and mixtures thereof.

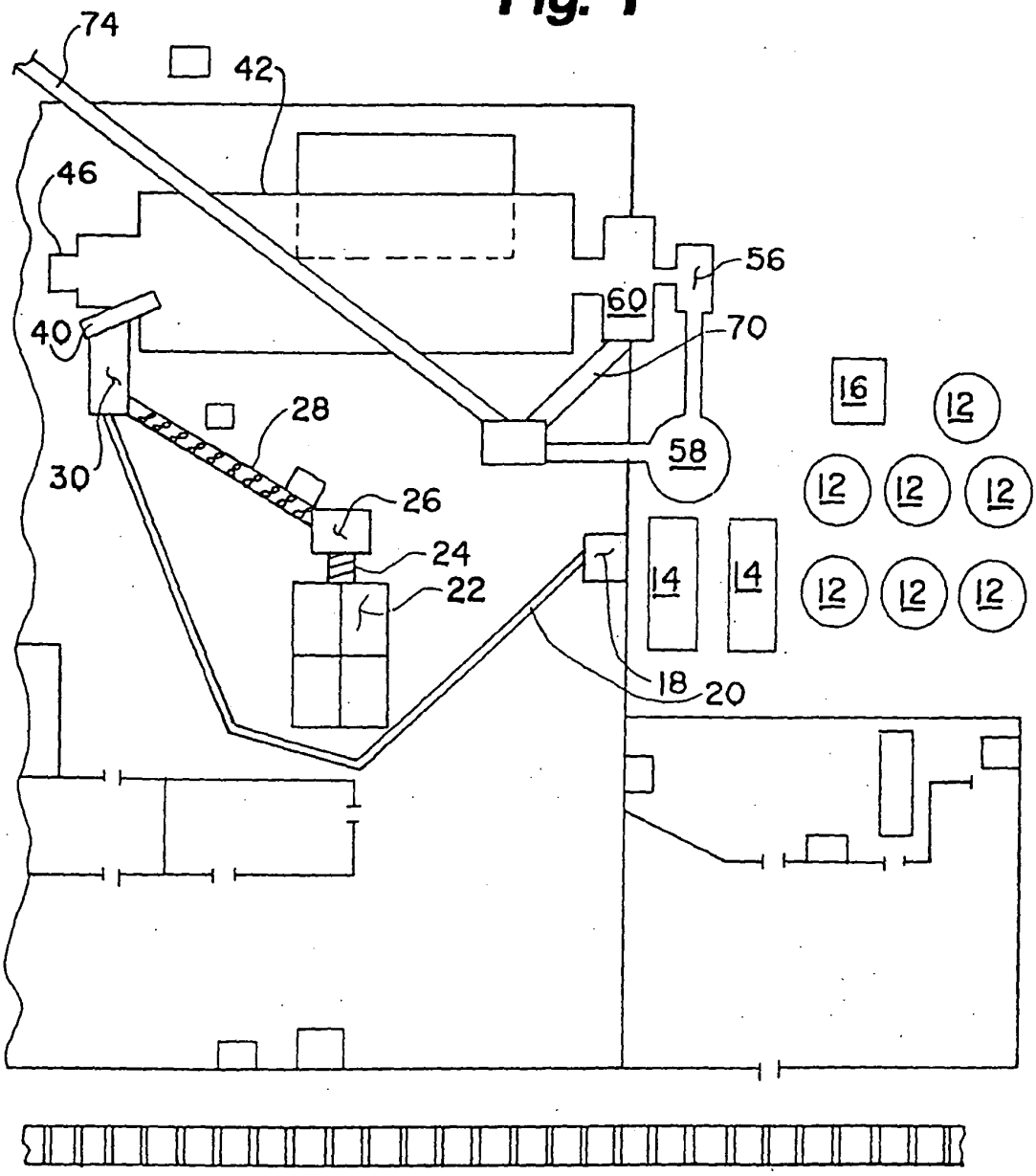
4. The process of claim 1 and wherein the feed grade liquid biomass is a 60:40 weight ratio mixture of monosodium glutamate fermentation byproduct liquor to condensed fermentation solubles (CFS) (byproduct of lysine production), wherein the feed grade dry substrate is wheat middlings, wherein the liquid:dry ratio on a volume basis is 2.25:1.0, wherein the moisture is 7 wt % and the warm material is 93 wt % solids.

5. A product produced by the process of claim 1.

6. A process for treating dairy cows to reduce the likelihood of milk fever comprising the steps of:

feeding the product of the process of claim 1 to cows during the "dry period" preceding lactation, wherein the product of the process is fed at a rate of from about 1.5 to about 2.5 pounds day.

Fig. 1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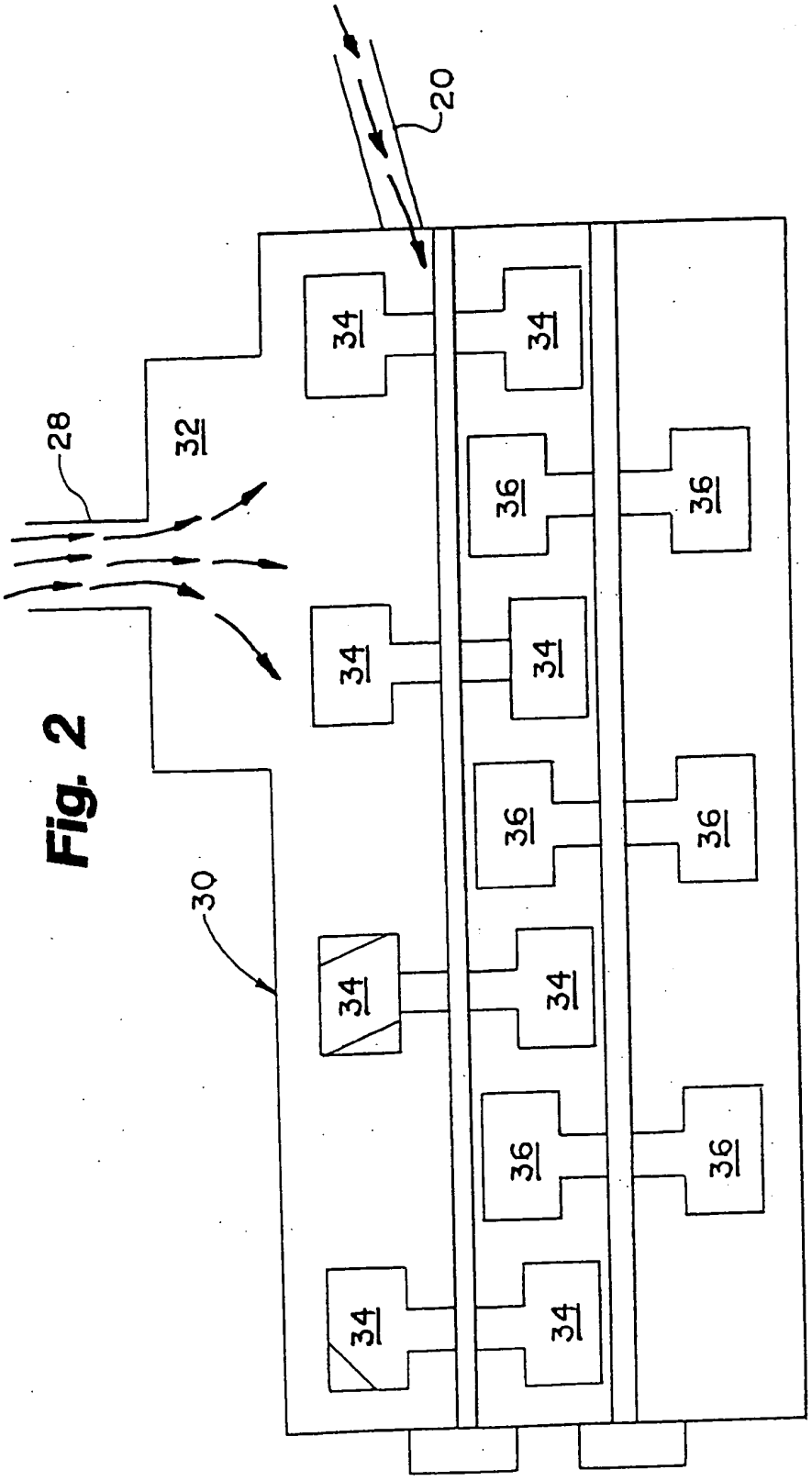

Fig. 2

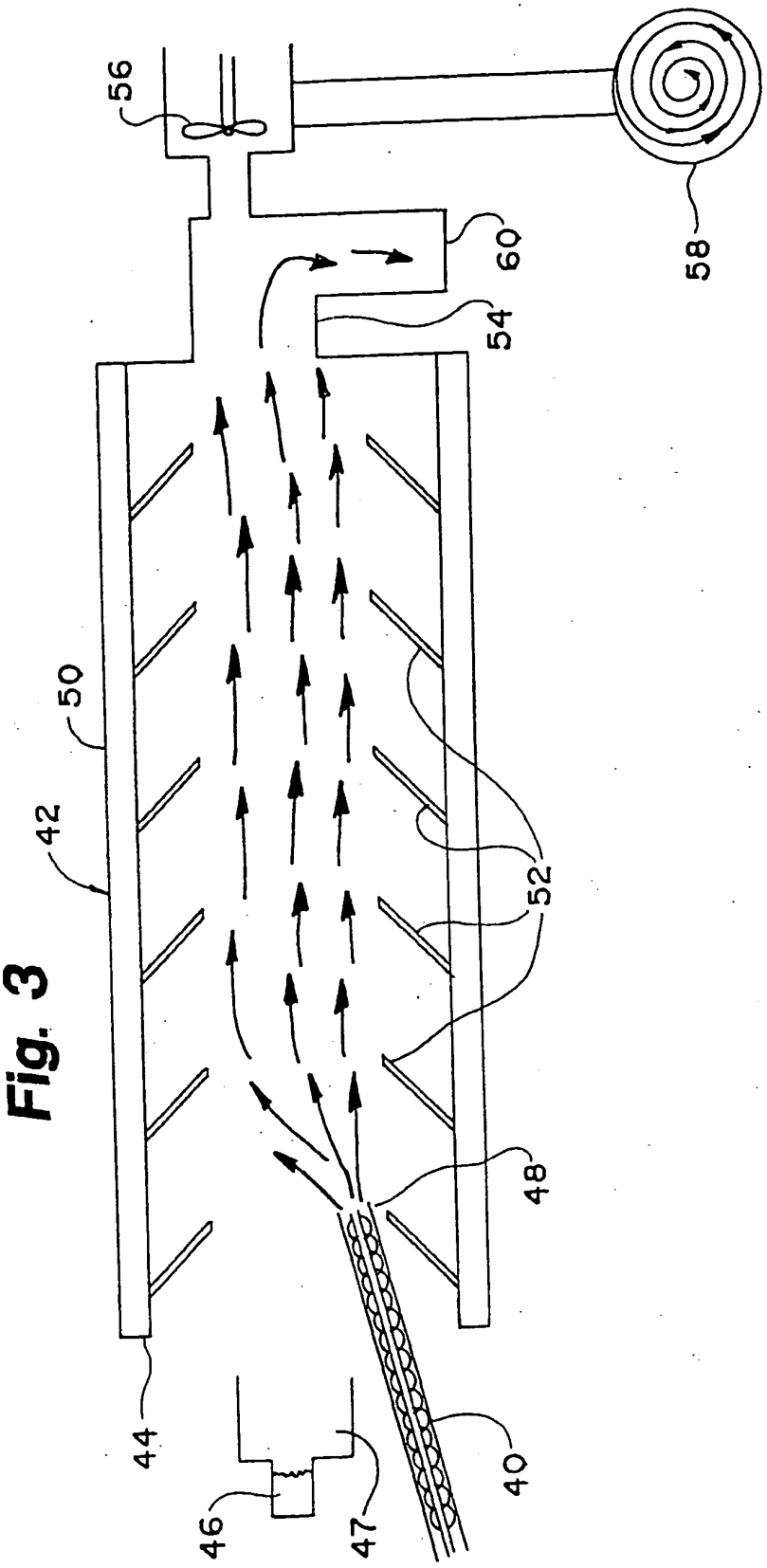

Fig. 3

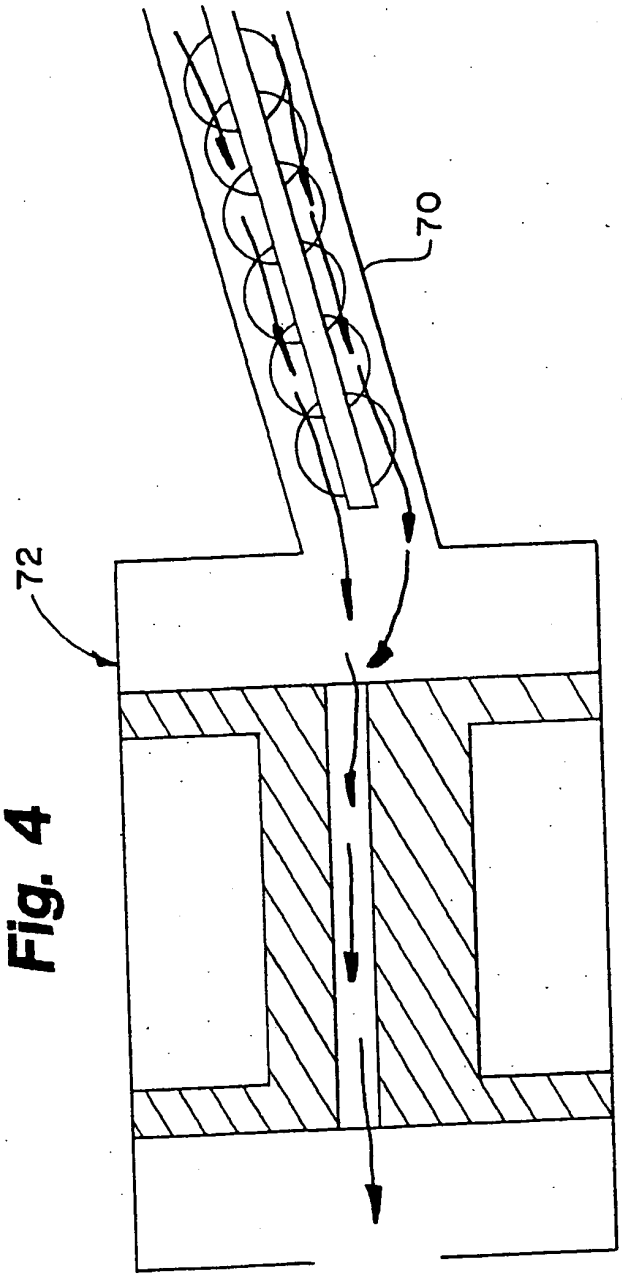

Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/09091

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :A23K 1/06, 1/188; A61K 33/08, 33/06, 31/19

US CL :Please See Extra Sheet.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 426/2, 31, 53, 54, 74, 231,624, 443, 465, 473, 519; 424/438; 514/706

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS, CAS ONLINE, WPIDS, FSTA
SEARCH TERMS: FEED, FERMENT?(2A)SOLUBLE# AND PREPAR?, GLUTAMIC ACID; MILK FEVER AND FEED SUPPLEMENT

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X, E	US 5,709,894 A (JULIEN) 20 JUNE 1998. NOTE ABSTRACT AND CLIAMS, COL. 4, LINES 60 ET SEQ.	1-6
Y, P	US 5,637,312 A (TOCK ET AL.) 10 JUNE 1997, COLUMN 12, LINES 38-68 AND COLUMN 13, LINES 13 1-21.	1-6
Y	US 5,393,535 A (KJEMS) 28 FEBRUARY 1995, ABSTRACT AND CLAIMS.	6
Y	US 5,360,823 A (GRIFFEL, JR. ET AL.) 01 NOVEMBER 1994, ABSTRACT, COL. 3, LINES 10-68.	1-6
A	US, 4,161,543 A (GLABE ET AL.) 17 JULY 1979.	1-6

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search	Date of mailing of the international search report
02 JUNE 1998	23 JUN 1998
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231	Authorized officer N. BHAT
Facsimile No. (703) 305-3230	Telephone No. (703) 308-0561

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INTERNATIONAL SEARCH REPORT

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426/2, 31, 53, 54, 74, 231,624, 443, 465, 473, 519; 424/438; 514/706